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CHRYSOPIDS AS A FACTOR IN THE NATURAL CONTROL OF THE ORIENTAL FRUIT MOTH

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During the summer of 1930 it was observed that large numbers of eggs of the Oriental fruit moth (*Laspeyresia molesta* Busck.) were being destroyed by some enemy which pierced the shell and sucked out the contents. The presence of many chrysopid larvae on the trees indicated that these might be responsible for the destruction of the eggs. These larvae were also a nuisance in the insectary at Vineland Station, getting on the twigs in the Oriental fruit moth oviposition cages and destroying large quantities of eggs. At the direction of Mr. W. A. Ross, the writer undertook some investigations on chrysopids at Vineland Station during part of the summer of 1930, and in various orchards from the Niagara river to Grimsby during the summer of 1931.

SPECIES OCCURRING IN PEACH ORCHARDS

Nine species of chrysopids were taken in peach orchards. These were *Chrysopa oculata* Say and its varieties, *xanthocephala* Fitch; *illepida* Fitch; *albicornis* Fitch and *chlorophana* Burm; *Chrysopa rufilabris* Burm.; *C. plorabunda* Fitch; *C. quadripunctata* Burm.; *C. downesi* Smith; *C. nigricornis* Burm.; *C. lineaticornis* Fitch; *Meleoma signoretti* Fitch and *M. emuncta* Fitch.

The species were determined by Professor Roger C. Smith of Kansas State Agricultural College, to whom grateful acknowledgment should also be made for the loan of a manuscript copy of his paper on Canadian Chrysopids prior to publication.

Only two specimens of *C. lineaticornis* Fitch were seen, these being taken in Oriental fruit moth bait pails at St. Davids. *Meleoma emuncta* Fitch was taken on seven or eight occasions at St. Davids, Niagara-on-the-Lake and Grimsby. *C. quadripunctata* Burm. was also rare, four or five specimens being taken at St. Davids and Niagara-on-the-Lake. *C. nigricornis* Burm. and *C. downesi* Smith were generally distributed throughout the district but were never common. *M. signoretti* Fitch was rarely taken on the trees, but was caught in considerable numbers in the fruit moth bait pails at St. Davids. These pails containing a solution of molasses, proved to be very attractive to all the chrysopid species which were found in the orchards. *C. oculata* Say was usually common in most orchards, particularly in those with many weeds or cover crops. *C. plorabunda* Fitch and *C. rufilabris* Burm. were by far the most abundant species, and were present in every orchard examined. Futhermore they were the only species found on peach trees in the egg and larval stages.

HABITATS OF THE SPECIES

Each species is more or less restricted to a definite habitat. This fact has been noted by other workers, particularly by Smith ('22) who has given in some detail observations with which those of the writer closely agree.

C. oculata Say appears to be restricted almost exclusively to low vegetation. Adults were frequently found on peach trees, chiefly on the lower limbs, but only one larva was observed on trees—a third instar larva taken on a low branch of a young peach tree. A large number of chrysopid eggs from peach and other trees were collected and reared, but none were *oculata*. Eggs of this species were found in great abundance in 1930 on a cover crop of rape at Vineland Station and in 1931 on turnips at Niagara-on-the-Lake. In both cases the plants were heavily infested with aphids. The larvae have been found on a wide range of low plants, usually in the vicinity of an aphid colony. The adults are very strongly attracted to aphids, and often become very abundant in the neighbourhood of a severe infestation of these insects, this being particularly noticeable in the case of the rape and turnips mentioned above. As it does not normally occur on trees, this species is of no importance in the control of the Oriental peach moth.

C. rufilabris Burm. is typically arboreal. Although no eggs were discovered on low vegetation, larvae frequently were, having most probably fallen from the trees. The majority of the chrysopid eggs collected on peach and many other trees, were of this species. Larvae were very frequently found on peach trees, although not nearly in as great numbers as the abundance of eggs would indicate. By far the greater proportion of chrysopid larvae observed on the trees were this species. Cocoons were commonly found spun up on the leaves and fruit. The adults were present in every peach orchard examined from approximately the middle of June to the first of October when the last observations were made. They were also taken on many other trees of several species—in dense woods as well as in the open. The adults are somewhat attracted to aphids, although much less dependent on them than *oculata*. At Niagara-on-the-Lake a belt of plum trees through the centre of a peach orchard bore a considerable infestation of aphids on water sprouts. The number of *rufilabris* on these trees was noticeably greater than on the adjacent peaches, and eggs were considerably more abundant. *C. rufilabris* Burm. is undoubtedly the species of greatest importance in the control of the Oriental fruit moth.

C. plorabunda Fitch appears to occupy a habitat intermediate between those of *C. oculata* Say and *C. rufilabris* Burm. and extending into both. It is less dependent on trees than *C. rufilabris* Burm. but it is very frequently found on them. No eggs of *C. plorabunda* Fitch were noticed prior to July 22, but after this date, as shown by weekly egg counts, 35 per cent of the chrysopid eggs an old trees and 73 per cent of those on young trees were of this species, the rest being *rufilabris*. This would indicate that *plorabunda* prefers lower trees. Eggs were also found on currant bushes and on tall weeds in and about the orchards. Larvae were seen occasionally on peach trees, and were also found on weeds and corn. The adults never occurred in woods, but preferred open ground with tall plants and small bushes. *C. plorabunda* Fitch may be of considerable value in the control of the fruit moth but is probably secondary in importance to *rufilabris*.

All the other species appear to be more or less arboreal, although very brief observations were made on them. As no immature stages were found in

the orchards, it would appear that they are of little or no value as enemies of

LIFE-HISTORY

The egg and larval stages of *C. oculata* Say, *C. rufilabris* Burm., *C. plorabunda* Fitch, *C. nigricornis* Burm., *C. quadripunctata* Burm., *M. signoretti* Burm., and *M. emuncta* Fitch were reared in the insectary. With the exception of the *Meleoma* species which the writer hopes to describe in a later paper, they have been described and figured by Smith. Only *C. rufilabris* Burm., *C. plorabunda* Fitch, *M. signoretti* Fitch and *M. emuncta* Fitch will be subsequently dealt with as the other species are of little immediate importance and their life histories insofar as determined by the writer do not differ from those given in Smith's paper.

The average number of eggs laid per female was not determined as it proved to very difficult to get reared females to oviposit in captivity. A female *plorabunda* which emerged in the insectary laid 69 eggs over a period of 21 days and 39 eggs over a period of 7 days. The average number is probably considerably higher than these figures, although it is doubtful if these smaller and weaker species are as prolific as *oculata* and *nigricornis* which appear to average between 150 and 200 eggs per female.

The incubation period of only a few eggs was determined. Four lots of *C. rufilabris* Burm. varied from six to seven days which is probably longer than the average. Four lots of *C. plorabunda* Fitch varied from five to six days.

The length of the larval period of *C. rufilabris* Burm. for 42 individuals reared between June 17 and September 10 varied from 10 to 16 days with an average of 13.1 days. The first instar averaged 4.1, the second 4.0, and the third 4.7 days. The larval period of *C. plorabunda* Fitch averaged 11.7 days for 14 individuals reared between July 28 and September 12. Larvae of this species and of *C. rufilabris* Burm. hatching on the same date matured in approximately the same time, so that the average larval period of both species for the whole season would be about the same. Only two larvae of *Meleoma signoretti* Fitch were reared, these hatching on August 29 and maturing in 16 and 17 days respectively. Three larvae of *M. emuncta* Fitch were reared, all hatching on August 20 and maturing in 22 days. The larvae reared for the above records were fed Oriental fruit moth eggs and various species of aphids.

By limiting the supply of food, it was found that the length of the larval period could be greatly extended, in the case of *rufilabris* to over 30 days, or more than double the normal period.

All species of aphids were not suitable for rearing the larvae. When green apple aphids, *Aphis pomi* DeGeet were used the duration of the instars was greatly prolonged and in most cases the larvae eventually died.

The time spent within the cocoon, including both the prepupal and pupal stages, ranged from 9 to 16 days for *C. rufilabris* Burm.—41 individuals averaging 11.7 days. Six *plorabunda* averaged 14.6 days during the cooler part of the season. As *rufilabris* emerged in approximately the same time during this period, both species probably averaged practically the same for the whole season. By watching for the appearance of the last larval moult, which appears as a black disc at one end of the cocoon, the beginning of the pupal period

can be determined. This occurred from three to five days after the spinning of the cocoon.

The complete life cycle of *C. rufilabris* Burm. and apparently *plorabunda* also, averages about 31 days. Under natural conditions in the orchard it is probable that few chrysopids would complete their life cycle within this length of time, as the scarcity of suitable food prevailing during most of the summer would extend the length of the larval period. As the adults began emerging early in June and both larvae and adults were still active at the end of September, there were at least two and probably three generations this year. These overlapped to such an extent that they could not be distinguished in the field.

FOOD OF THE LARVAE

Little information concerning the food of the larvae in orchards could be obtained by actual field observations, but by noting the insect population of the trees, a good idea of its nature was obtained. The only food actually seen eaten by a larva was a cicadellid nymph. Leaf-hopper nymphs of a number of species were generally the commonest forms suitable for food and could be found practically throughout the summer, although they were far from being abundant. They probably form the greater part of the food of chrysopid larvae on peach trees. Small pale green nymphs of some species of aleyrodid were frequently found on the leaves and were doubtlessly also eaten as well as a few thrips. Aphids were present in small numbers at the beginning of June but soon entirely disappeared to reappear late in September. The most striking feature of the insect population of the trees was its paucity especially of lepidopterous and other larvae.

PARASITISM

During the latter part of the summer, after approximately the middle of July, there was an appreciable amount of parasitism of chrysopid eggs by *Trichogramma minutum* Riley. The highest recorded percentage of parasitism by this insect was 12 per cent at Niagara-on-the-Lake. Pupal parasitism was very slight; out of many cocoons collected in the orchards only three proved to be parasitized, one by a chalcid, *Hemiteles* near *tenellus* Say. and the other two by an undetermined ichneumonid.

FLUCTUATIONS IN NUMBERS IN ORCHARDS DURING 1931

The first specimen of *C. rufilabris* Burm. seen this year was taken on June 10 and the first egg was also found the same day. After this date the number of adults increased rapidly and judging by rough observations, remained more or less constant from July 1 until early September. Egg deposition reached a peak between July 2 and 16 and then fell off rapidly. This period between July 2 and 16 represents the time of maximum oviposition of the overwintering generation; the reduction in numbers of eggs therefore took place in the succeeding generations.

The cause of this reduction is not clearly apparent. It was not caused by parasitism as this was negligible. A possible cause was the deficiency of food for the larvae; only a small percentage of the latter hatching from the abundance of eggs could reach maturity on the trees. It was also noticed that the adults occurring in the orchards during the latter part of the summer were

noticeably smaller and weaker, probably owing to starvation of the larvae, and were no doubt less prolific.

The last eggs found in the field were seen on August 27, but small numbers were probably deposited for sometime later, as the adults were present in considerable numbers till the end of observations on the first of October.

C. plorabunda Fitch was first noticed in the orchards on July 22. It is apparent that this was the beginning of the second generation. The first generation must have been passed elsewhere than in the orchards, or was represented by such small numbers that it was not noticed. In Kansas and Michigan this species hibernates as an imago. It is altogether probable that it does so in Ontario but the severity of our winters would probably allow only a small number to survive, with the result that the first generation in the spring would be much reduced. The development of this species during the rest of the season appeared to parallel that of *C. rufilabris* Burm.

INFLUENCE OF APHIDS ON THE CHRYSOPID POPULATION

At the beginning of these studies it was believed that fluctuations in the number of aphids from year to year might influence the number of chrysopids and their attacks on fruit moth eggs, because in 1930, the year in which their effect on fruit moth eggs was first noticed, aphids were very scarce, while the previous year they had been very abundant. However, in 1931 chrysopids were again very abundant following a year of aphid scarcity, so it is doubtful if the prevalence of aphids has much effect on the numbers of *Chrysopa rufilabris* Burm. and *C. plorabunda* Fitch. in the orchards.

RELATIONS TO THE ORIENTAL FRUIT MOTH

Hungry chrysopid larvae in all three instars and of both important species readily ate fruit moth eggs when these were supplied. Many larvae were successfully reared on the eggs, the percentage reaching maturity being higher than when fed on any other food. The number of eggs consumed by a larva from hatching to maturity ranged from 377 to 679 in the case of *C. rufilabris* Burm. and 360 to 670 in the case of *plorabunda* averaging 535 and 511, respectively. When the larvae were fed on a limited number of eggs, fewer were required to bring them to maturity; in one case a *rufilabris* larva matured after eating only 262 eggs.

Under natural conditions in the orchards this season, fruit moth eggs would form a very small percentage of the food of the larvae for during the greater part of the season chrysopid eggs were much more abundant than those of the moth.

The appearance of sucked eggs varies greatly. If an egg is sucked slowly, as by a young larva or is only partly emptied of its contents, it usually collapses. If it is sucked rapidly, the chorion very frequently retains its shape and closely resembles a normal hatched egg. If both freshly hatched and sucked eggs are present together they can be distinguished apart as sucked eggs have a somewhat whitish appearance, the hatched eggs being slightly more hyaline, but this difference soon disappears on exposure to weather. When wet with rain or dew both sucked and hatched eggs usually collapse. When a chrysopid larva sucks an egg it may tear the chorion considerably with its mandibles or pierce it only in one place, the rent so made frequently resembling

that made by an emerging larva. The only sucked eggs that can be definitely identified in the orchards are those not completely sucked or in which the head capsule of the embryo had formed. Many of these were found on the trees, but as they represent only part of those sucked by chrysopids, it is not possible to determine the percentage so destroyed.

While chrysopid larvae are of greatest importance as destroyers of the eggs, they also undoubtedly destroy many fruit moth larvae. They carefully probe every cavity and crevice, and in the insectary were observed extracting young larvae from deep within the axils of buds. The writer has observed them attacking corn borer larvae within the stalks and they are known to enter the tunnels of plum curculio and destroy the latter in peaches (Walsh and Riley, 1868), so it is possible that they attack Oriental fruit moth larvae in a similar manner.

CONCLUSIONS

Chrysopids are an important factor in the natural control of the Oriental fruit moth; although it is not possible to determine the actual percentage of eggs and larvae destroyed. The species responsible are *Chrysopa rufilabris* Burm. and to a lesser extent *C. plorabunda* Fitch. Other species may possibly assist to a limited extent, but *C. oculata* Say is of no importance. The number of chrysopids in the orchards appears to be influenced to a considerable extent by the occurrence on the trees of suitable food for the larvae, and is little influenced by a general scarcity or abundance of aphids.

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THE BIOLOGY OF THREE NORTH AMERICAN SPECIES OF MESOVELIA (HEMIPTERA-MESOVELIIDAE)*,†.

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(continued from page 120)

Incubation.—Eggs laid in the laboratory January 25 required only 12 days to hatch. This is apparently the length of the normal incubation period. The embryo does not completely fill the egg until shortly before hatching, and its white color forms a contrast against the transparency of the egg shell.

Many eggs laid August 17 and during the following month, however, hatched out one and two at a time in April. I noticed on February 11 the deep red eye spots of a *Mesovelia douglasensis* Hung. egg that was deposited September 1. Segmentation was plainly visible four days later and it hatched out sometime during the morning of February 17.

Hatching.—Since there was no peak in the hatching period, the little fellows emerging one at a time intermittently, no data on hatching was secured. The hatching is presumed to be similar to that related for *Mesovelia mulsanti bisignata* Uhl., however. The newly hatched nymphs are light col-

ored with prominent red eyes, but a few hours exposure causes them to darken materially.

Behavior of the newly hatched.—The little nymphs are quite active soon after hatching, and skate or walk about their container as if exploring their homes. They are not nearly so active and restless as *Mesovelia mulsanti bisignata* Uhl., however, and seldom try to escape by scampering up by the sides of the stender. They feed within a few hours after hatching. If disturbed or placed in deep water, they draw their legs up close to the body, remain very quiet, and can hardly be distinguished from a piece of cattail leaf or other debris. This procedure no doubt serves them well in nature, for the nymphs are even hard to detect in laboratory containers. Like the other two species, *Mesovelia douglasensis* Hung. incessantly "cleans up" from the time it hatches until it dies.

Number of instars.—There are five nymphal instars.

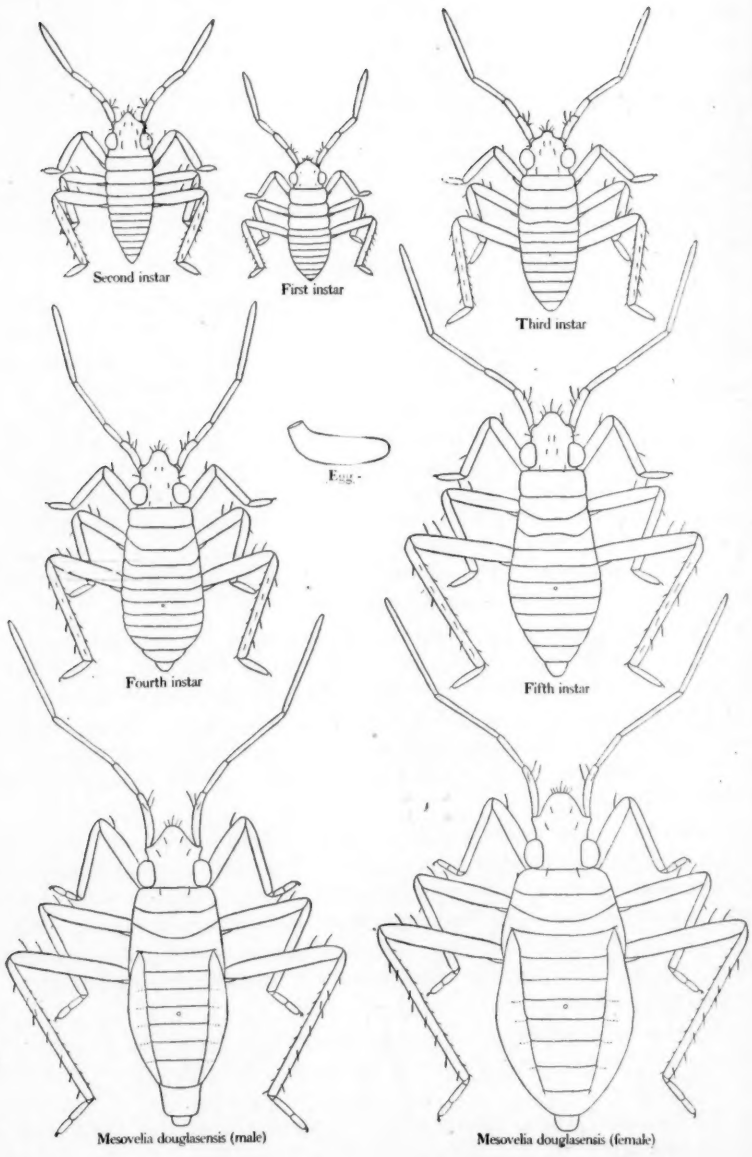
Molting.—Molting takes place on the vegetation provided, on the sides of stender adjoining the water level, or on the water itself. Most of the nymphs, however, molt on the sides of the stender. The skin splits along the median line of the head and thorax, and the antennae and beak emerge about the same time. The nymphs molt by successive forward lunges, the head slumping down after each effort until the skin is cast. The wrinkles in the body wall are straightened out by the circulation of the body fluids, which are visible as soon as the body of the bug is free from the old skin. The hind legs, which are stretched straight back during molting, are moved a great deal during the process. When the bug is free except for one of its hind legs, it often uses the prothoracic and metathoracic legs of the same side to free itself, while if one hind leg is already free it serves to steady the body.

The actual molting time, which requires only a few minutes, varies with different specimens. Some molt easily, "clean-up" a little, and feed immediately, while others have difficulty in freeing the legs, particularly the hind ones. Sometimes they can be saved with a little help, but without this aid the nymph dies of exhaustion. Mortality is great in the first instar and occurs chiefly when the bug has passed its regular molting time. Death usually occurs before the skin has split.

Longevity—Four males and four females collected at Bryant's Bog, Douglas Lake, Michigan, on August 29 were placed in a food container supplied with sphagnum moss and taken to Kansas. The bugs seemed none the worse for their journey, and the females deposited many eggs during the next month. Between the 4th and 11 of October, however, they had all succumbed. The average span of life of the reared ovipositing females is about two months, while that of the males is slightly longer.

Number of generations.—There is apparently a succession of generations throughout the season, since the nymphal development requires approximately twenty-five days.

Food habits.—These little bugs are predaceous, and probably live on the same fare in nature as *Mesovelia mulsanti bisignata* Uhl. In the laboratory, they were reared on adult houseflies and fruit flies. The latter proved to be the better food, because their bodies can be pierced easily and because the water


Second instar
First instar
Third instar
Egg
Fourth instar
Fifth instar
Mesovelia douglasensis (male)
Mesovelia douglasensis (female)

does not become so polluted as when houseflies are used. If a number of adults are kept in the same container, they will feed on their dead comrades or kill and feed on one that is about to die. A number of adults lived very well in an aquarium, the water of which contained *Chara* and an abundant supply of entomostracans.

Behavior.—In nature these bugs are hidden amongst the *Chamaedaphne* just as *Mesovelia cryptophila* Hung. and it is impossible to observe them. Nevertheless, they can be observed readily in the laboratory as they go about their everyday work. This little species cleans itself without cessation as does the former species and in the same manner. The males spend the greater part of the day resting or walking about on the cattail leaf, while the female rarely frequents it unless it is for oviposition. Much of their time is spent on the sides of the stender, either out of the water or near the surface of the water, but always facing it and ready to descend when disturbed.

As was mentioned under oviposition, the females often lay eggs on the surface of the cattail leaf in company with a number of empty egg shells. The writer had the good fortune to observe the causal factor in the production of egg shells as he watched a female depositing eggs in late August. She deposited a number of eggs on the surface of the cattail leaf and then took her beak and explored one of these eggs from end to end. Finally, after examining the egg thoroughly, she inserted her beak in the bulb-end of the egg and sucked out the contents. Naturally the egg collapsed and became just a flat transparent empty shell. No doubt only a few eggs laid on the surface escape this procedure.

This species has the habit of floating when it is met by an influx of water or if its container is turned on end. The front legs are kept forward, the middle ones horizontal, while the hind legs are stretched straight back. But this "frog-like" position does not keep the insect from readily drawing its legs into a normal position and skating away from approaching danger.

DESCRIPTION OF STAGES

Egg.—The general shape of the egg is like that of the other two species, and is best shown in the drawing. Hungerford (12) gives the following description: "The egg is elongate oval, with a curved neck terminating in a flat surface which marks the exposed end of the egg as it lies *in situ* in the plant stem. It measures .75 mm. in length and .2 mm. in width and is a little plumper than the egg of *M. mulsanti*. The curved neck is larger proportionately." Measurements of ten eggs of this species show the average length of the egg to be .75 mm., the average greatest diameter .22 mm., while the average diameter of the exposed circle is .13 mm. The egg is white when first laid, but within a few days it becomes watery transparent and the embryo begins to take form. The deep red eye spots are evident 6 days before hatching, and segmentation in the embryo is visible two days before the nymph emerges.

First instar.—When first hatched the nymph is white with red eyes, but as it ages the antennae, legs, thorax, and the dorsum of the abdomen become greenish-brown. The remainder of the abdomen varies from yellow to orange in color. The size of this instar is given in the Table of Measurements. It is much smaller than the first instar of either *Mesovelia mulsanti bisignata* Uhl. or *Mesovelia cryptophila* Hung. and can be readily distinguished from them by

its size. As in the other two species, the body and limbs of *Mesovelia douglasensis* Hung. are covered with hairs and bristles. Two or three stout bristles. are present on the first segment of the antennae, while the other three segments are covered with short hairs, those of the terminal segment being very fine. The antennae are four segmented and stout, while the legs are stout and have one-segmented tarsi.

Later instars.—The color of the head and thorax of the remaining instars may vary from light green through brown, and the abdomen from light yellow to orange with tints of red and brown. The eyes are red and the antennae and limbs are smoky colored. The color variation in the instars of this species is so great that color is not reliable enough to be used for the differentiation of the various instars. The abdomen of some of the fourth instar nymphs becomes very "blocky" in form, but this does not seem to indicate a sexual difference, for both males and females have been reared from "blocky" forms. The three pairs of setiferous dots located on the head are brown until the bug becomes adult, after which they are black. The dorsum of the fourth abdominal segment bears the repellant gland pore.

As in the other two species, there appears one black bristle on the anterior margin of the fore femur and two on the other femora. The adults of *Mesovelia douglasensis* Hung., however, retain the two or three stout bristles on the first segment of the antennae that prevail in the earlier instars, instead of undergoing a reduction as is the case of *Mesovelia mulsanti bisignata* Uhl. The stout spines on the rear margin of the first and middle femora of *Mesovelia mulsanti bisignata* Uhl. are lacking or minute in this species, as was noted by Hungerford (12). The limbs, which are very slender, have three segmented tarsi. Upon becoming adult the connexivium and other sexual characteristics appear. A Table of Measurements of the various instars and of the adults is appended.

TABLE 3.

Measurements in Millimeters of *Mesovelia douglasensis* Hung.

Stage	Length of Beak	Width of Head Across Eyes	Antennae				Fore leg			Middle leg			Hind leg			Body		Measurement from tip of Femur to tip of Femur (Hind Legs)
			1st seg.	2nd seg.	3rd seg.	4th seg.	Femur	Tibia	Tarsi	Femur	Tibia	Tarsi	Femur	Tibia	Tarsi	Length	Greatest Width	
1st instar	.306	.255	.102	.085	.136	.374	.153	.187	.102	.204	.221	.102	.255	.374	.119	.867	.289	.799
2nd instar	.424	.289	.153	.119	.204	.442	.204	.238	.136	.255	.289	.136	.357	.476	.153	1.071	.391	.952
3rd instar	.476	.340	.187	.136	.238	.476	.238	.272	.136	.289	.340	.153	.425	.578	.170	1.224	.510	1.088
4th instar	.612	.396	.216	.180	.396	.576	.324	.360	.180	.396	.468	.216	.576	.792	.252	1.620	.684	1.476
5th instar	.756	.468	.324	.216	.468	.720	.396	.468	.216	.504	.612	.252	.648	1.000	.324	1.908	.720	1.872
6th ♂ instar	.864	.504	.324	.288	.540	.792	.540	.540	.288	.612	.684	.288	.864	1.152	.396	2.304	.720	2.268
6th ♀ instar	.864	.540	.324	.288	.540	.720	.540	.540	.252	.648	.720	.288	.900	1.224	.396	2.484	1.152	2.340

SUMMARY OF LIFE HISTORY STUDIES

62 specimens were reared from hatching to maturity, 32 of which were males and the remaining 30 females. The method of computing the average, minimum, and maximum duration of a given instar, or of total nymphal de-

velopment, is the same as explained under *Mesovelia mulsanti bisignata* Uhl.

The mortality in the first two instars included 16 specimens. The first and fifth instars appear to be the most crucial times in the lives of these insects.

By referring to the table, we see that 87 nymphs spent an average of 4.3 (minimum 2, maximum 7) days in the first stadium; 87 nymphs spent 4. (minimum 1, maximum 7) days in the second stadium; 79 nymphs spent 4.4 (minimum 3, maximum 7) days in the third stadium; the average duration of the fourth stadium for 76 specimens was 5.4 (minimum 3, maximum 9) days; the average duration of the fifth stadium for 61 specimens was 7.1 (minimum 5, maximum 10) days.

The 62 specimens reared to maturity required an average of 24.9 days (minimum 19, maximum 37) for their nymphal development. There appears to be little difference in the length of the developmental period of males and females. An attempt was made to rear a number of specimens in a constant-temperature chamber, which was kept at 80°F. The result was that most of the nymphs died before molting for the first time, while one isolated February 14 died as a fifth instar, having spent 17 days in that stage. This specimen spent 3, 5, 4, and 8 days respectively in the first four stages. Thus, the nymphal development of *Mesovelia douglasensis* Hung. is slowed down at a temperature of 80°F., whereas it seems to continue regularly at 74°F.

METHOD OF REARING

Adults were collected and divided according to species, after which they were isolated in finger bowls containing lake water and several pieces of decayed cattail leaf for oviposition. The water was changed daily, and houseflies served as food. When a large number of eggs were laid in the stem provided, it was then removed to a petri dish and given a number that corresponded with that on a card. Permanent data were, of course, kept on cards, which enabled one to keep an accurate account of hatching. An eye dropper was used to change the water in the egg containers, and a dropper or two full of water was sufficient for the daily change. Only a few nymphs hatched while the writer was in Michigan, so the pieces of cattail leaf containing the eggs were embedded in sphagnum moss in vials. These were then taken to Kansas on September 1 and re-isolated in petri dishes containing cistern water.

The little nymphs that hatched out were isolated in small stenders one inch deep and two inches in diameter and in some other stenders slightly larger. The stenders containing a single bug were numbered and a corresponding card was made. Each stender was supplied with a single dropper full of water, a small piece of white card, and two adult fruit flies for food. The card served as a support for the little fellows, and being white did not interfere in the search for molted skins. The bugs flourished with a daily change of water and a fresh supply of food every other day, the remains of the previous feeding being removed at this time. Neither the size of the container nor the amount of food seemed to alter the size or the well being of the bugs.

After the aphids used as food during early attempts at rearing proved to be inefficient, houseflies were tried. They served as good food but scarcity along the latter part of January necessitated the finding of a food supply plentiful enough to care for many rearings. It was found that adult fruit flies filled the

need, and of course they were easy to rear in quantities. The technique used might well be related, however, for it affords a simple way of capturing the adults to be used as food for winter rearings. A lamp chimney covered at one end with a piece of cheesecloth, fastened by means of a rubber band, was placed over a pint jar in which a banana and the fruit flies were placed. In a short time, the chimney was swarming with the adults. To capture a hundred or more specimens, the writer slipped a four inch vial through a piece of cardboard, in which a sufficiently large hole had been cut, and placed it over the top of the chimney as soon as the cheesecloth was removed. Ordinary light attracted many of the adults into the vial, but with the use of an artificial light above the vial, the desired number could be readily secured. When this number was obtained, the vial was quickly corked and something put over the chimney until the adults were scattered again. The chimney was then re-covered with cheesecloth with the loss of but few adults. The adults in the vial could be killed by placing it over a hot radiator for a few minutes, or by striking a match and applying the flame to the bottom of the vial. In the latter case, the fruit flies could be forced to the bottom of the vial by sudden taps against something that would not break it. Heat kills the flies quickly and does not injure them for feeding purposes.

It is often difficult to find the newly hatched bugs, because they cling to the surface from which they issue. In changing the water of the egg cages daily, therefore, the fresh water was squirted directly on the surface mentioned and the young washed off into the clear water. These were then easily transferred to stenders by tilting the petri dish and placing the tip of a pair of forceps under the nymph, thus lifting it out together with a drop of water. Although cistern water was substituted for lake water and later well water for cistern water, these changes affected neither the well-being of the long matured adults nor the rearings in progress.

SUMMARY

Mesovelia mulsanti bisignata Uhl., the largest and most common of the three species of American Mesovelia discussed in this paper, is found upon floating vegetation about the margins of ponds, bogs, and other bodies of water. All three species considered here feed on insects caught upon the surface film and probably upon small crustacea which are found near the surface of the water. They are thought to overwinter as adults, but conclusive evidence concerning this point is lacking because frequent searches at Lake View throughout the winter months failed to reveal any hibernating adults. Laboratory experiments show that the eggs can withstand zero temperature for a month and hatch, so the bugs may pass the winter in the egg stage. This view is substantiated by the fact that the writer found only first instar nymphs at Lake View on May 2, 1931. Oviposition occurs in the spring, the eggs being deposited in the stems of plants. There are five instars, and a succession of generations throughout the season. The winged and wingless forms occur together. The 48 specimens carried through from the abandonment of the egg to maturity required an average of 20.02 days (minimum 17, maximum 24 days) for their nymphal development.

Mesovelia cryptophila Hung. dwells amongs the thick growth of *Chamaedaphne* in Nichol's Bog, a bog located in an upland pasture in the region of Douglas Lake, Michigan. The females possess an ovipositor and lay eggs in the plant tissue as is true of the preceding and following species. Only apterous forms of this species are known. *Mesovelia cryptophila* Hung. has only four nymphal stages, an unusual number for *Mesovelia* as well as for most semi-aquatic Hemiptera. The five specimens reared from hatching to maturity required an average of 17.6 days (minimum 16, maximum 21 days) for their nymphal development.

Mesovelia douglasensis Hung. is found beneath the dense growths of *Chamaedaphne* about the margins of some bogs in the Douglas Lake region, Michigan. It was previously known to occur only in Bryant's Bog, so the writer is glad to record it from a larger one known as Livingston's Bog. Since the eggs laid in cattail leaves in August were still hatching in April, and since some of these were kept at 32°F. for a month and hatched, it is possible that the bugs pass the winter in the egg stage. There is apparently a succession of generations throughout the season. There are five nymphal instars in this species, and only apterous forms are known. Sixty-two specimens reared to maturity required an average of 24.9 days (minimum 19, maximum 37 days) to complete their nymphal development.

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SOME ERYTHRONEURA (GRAPE LEAF HOPPERS) OF THE MACULATA GROUP. (HOMOPTERA, CICADELLIDAE)

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(continued from page 88)

71. **Erythroneura confirmata** McAtee.

Erythroneura maculata var. *confirmata* McAtee, W. L. Fla. Ento. Nos. 3 and 4, Vol. VIII, p. 34, Dec. 1924,
Erythroneura mitella McAtee, W. L. Bull. Ill., Nat. Survey, Article III, Vol. XVI, p. 132, 1926.

The following is the original description: "Markings of head, thorax and scutellum as usual in the *maculata* type, yellow; tegmen with a streak along claval suture anteriorly, an oblique dash at base of corium and another at anterior end of costal plaque, yellow; dot at posterior end of plaque, and in base of fourth apical cell black; and the following markings red, broad vitta based on costal plaque, extending inwardly and crossing clavus as oblique broad band, and a straight narrow stripe, connected narrowly behind to a spot which spreads so as to fill spaces between sectors anterior to third and fourth apical cells, also ramose marking on cross veins; costal plaque dusky bluish hyaline, apical cells fumose. Color below pale yellow. Length: 2.75 mm.

Holotype, and paratype males, Chain Bridge, Va., April 23, 1922, J. R. Malloch."

Genitalia of holotype. Pygofer hook of medium length, quite heavy, widest beyond base, carrying this width to just before tip where it narrows to about half the width, strongly incurved on outer half of enlarged portion, then straightening out on narrowed part. Style with medium foot; large heel; anterior point third longer than width of toe, sharp, about half as wide at base as toe; posterior point about half as wide and slightly more than half as long as anterior, very sharp. Oedagus slightly bent dorsally, quite long, cylindrical.

This species can easily be distinguished from all others of this group by the peculiar pink markings of the tegmina and by the genitalia.

A male paratype of *E. mitella* McA. has been dissected and found to agree in all main essentials with the dissection of the holotype of *confirmata.*

72. **Erythroneura rubranotata** Beamer

Erythroneura rubranotata Beamer, R. H. Can. Ent. LIX, p. 30, Feb. 1927.

Genitalia. Pygofer hook single, of medium length, slightly wider near middle than at either end, tip curved out. Style with medium foot; base curved; heel large; anterior point less than a right angle, projecting out; posterior point longer than foot, sides almost parallel, inner margin forming much less than a right angle with base of foot. Oedagus very short, curved in lateral view, sides almost parallel, tip quite spiny.

73. **Erythroneura accola** McAtee

Erythroneura maculata var. *accola* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, 299, 1920.

"Like variety *maculata*, red form except that posterior third of clavus is occupied by a solid red patch of deeper red color than the other tegminal markings.

Length, 2.83 mm.; vertex: LM 5.5, LE 3.5, WA 10, WP 17.5, OA 6.5, OP 10.5, OH 15; pronotum L 11, W 20; tegmen 13-60.

Type, male; Plummer's Island, Maryland, Dec. 21, 1913, (W. L. McAtee), [W. L. M.]."

General ground color yellowish white to semi-hyaline. Color markings deep red on vertex, pronotum, scutellum and posterior third of clavus excluding very tip and orange on other parts. Vertex with two longitudinal vittæ which converge at tip and connect with anterior margin of each eye by a narrower stripe. Pronotum with an elongated bright red spot whose posterior tip touches posterior margin and whose anterior corners touch anterior margin as vittæ, meeting those of vertex and of same width. Usual red spots behind each eye. Scutellum with tip covered with bright red spot, connected with anterior margin by two narrow vittæ of same color, basal angles yellow. Clavi with rather small orange spot somewhat anchor-shaped in base and an elongated bright red spot covering entire width just before tip. Coria with a small orange spot on costal margin about one-third distance from humeral angle to costal plaque, an irregular margined, angulate vitta more or less surrounding costal plaque, ending near claval suture some distance before base of cell M_4. Some reddish color on cross-veins. A very small black spot in posterior end of costal plaque and a much larger one in base of cell M_4. Tips of tegmen more or less dusky. Venter stramineous more or less tinged with pink.

Genitalia. Pygofer hook single, of medium length, slightly narrower one-third distance to tip, curving slightly in and then out again; foot medium; base curved near heel; heel large; anterior point short about a right angle; posterior point sharp about as long as width of toe, extending at right angles from it. Oedagus short, narrow, and straight in any view.

This species is raised from varietal to specific rank.

Allotype; female, Gallatin Co., Ill., March 31, 1929, R. H. Beamer. In Snow Entomological Collection.

74. **Erythroneura osborni** DeL.

Typhlocyba osborni Delong, D.M., Tenn. State Bd. Ent., Bul. No. 17, Vol. 5, No. 2, p. 103; 1916.

General ground color yellowish white to semihyaline. Color markings bright red and yellow or orange. Vertex with semblance of three white spots surrounded by orange or yellow bands. Pronotum with transverse rectangular median spot with anterior corners tending to project forward. Usual angular mark behind each eye. Tegmen marked with a broad bright red cross-band reaching from just short of base to costal plaque, an orange spot on clavi just before tip, an angulate vitta from opposite middle of costal plaque to base of Cell M_4 and spot at base of cell M_2. Black spot in posterior end of costal plaque and base of cell M_4. Tips of tegmen slightly dusky. Venter stramineous.

Genitalia. Pygofer hook single, very short and thick, contracted near tip to sharp point, slightly curved in. Style with long foot; base almost straight; heel small; anterior point small about a right angle; posterior point very short

and sharp about a third as long as toe is wide. Oedagus in dorsal view rather short, parallel-sided with a pair of widely diverging, heavy, lateral processes.

Three of the five specimens in the Snow Collection were swept from Hickory in Arkansas.

75. **Erythroneura osborni** var. **dulcis** McA.

Erythroneura bassilaris var. *dulcis* McAtee, W.L. Trans. American Ent. Soc., XLVI, p. 296, Aug. 26, 1921.

The original description is as follows: "Tegminal band pinkish, tegminal spots yellow, markings on scutellum and anterior parts translucent to livid.

Length, 2.64 mm.; vertex: LM 6, LE 3, WA 11, WP 18, OA 5.5, OP 10, OH 14.5; pronotum; L 9.5, W 19; tegmen 13-55.

Type—female; Plummer's Island, Maryland, March 18, 1917, (W. L. McAtee), (W.L.M.)."

General ground color pearly white. Vertex red except lateral margins and mark in shape of figure 3 on disc pearly white. Pronotum with angular red spots back of each eye and cross-wise rectangular red mark on disc, which tends to be connected anteriorly. Scutellum with basal angles narrowly bordered with red, tip with red spot. Tegmina with red cross-band from just short of humeral angles to almost middle of costal plaque. This color not dense hence of pinkish tinge. Clavi with longitudinal orange spot before tip. Coria with an orange spot encircling outer end of costal plaque and angling almost to mesal margin and cross-veins. Part of cross-veins also orange. Small black spot in posterior end of costal plaque and larger one in base of cell M_4. Tips of tegmen tinged with brownish. Venter stramineous with pinkish tinge on legs.

Among the many specimens of this species at hand some have the pink or light red cross-band of tegmina absent or only slightly marked.

Allotype; male, Douglas Co., Kans., 1926, R. H. Beamer.

Parallotypes; 21 males from Kansas, Illinois, and Washington, D. C.

76. **Erythroneura bella** McA.

Erythroneura maculata var. *bella* McAtee, W.L. Trans. Amer. Ent. Soc., XLVI, p. 300, Aug. 26, 1920.

"Like the red form of var. *maculata* except that the anterior two-thirds of the clavus and sometimes a spot on adjoining corium is red.

Length, 2.9 mm.; vertex LM 6.5, LE 3, WA 11, WP 185, OA 5.5, OP 10, OH 15; pronotum: L 11, vertex 2-; tegmen 13-59.

Type—female; Plummer's Island, Maryland, Dec. 21, 1913, (W. L. McAtee), (W.L.M.). Paratypes (2.83 mm.); same locality, Oct. 10, 1906, (A.K. Fisher) and October 26, 1913, (W.L. McAtee), W.L.M.)."

General ground color yellowish white to semihyaline. Color markings red to orange or yellow in summer specimens. Vertex with three light spots surrounded by red, often with a red spot at tip. Pronotum with light band across base and light rectangular median spot on anterior margin, remainder more or less covered with red. Scutellum yellow with basal angles margined with red except bases. Clavi with basal two-thirds solid bright red, another fainter spot just before tip. Coria with small dash of color on costal margin midway between humeral angle and costal plaque, narrow band about anterior

end of costal plaque, larger rectangular spot between claval suture and Cu opposite outer end of heavy claval spot and more or less color on veins and cross-veins. Customary black spot in posterior end of costal plaque and base of cell M_4. Venter stramineous tinged with pink.

Allotype; male, White Co., Ill., March 31, 1929, R. H. Beamer.

Genitalia. Pygofer hook single, short, narrower at base than middle where it curves inward; outer two-thirds covered with short spines. Style with medium foot; base curved; heel large; anterior point very short, less than a right angle, projecting outward; posterior point longer than foot, almost parallel sided, at right angles to foot. Oedagus of medium length; in lateral view narrow, slightly curved dorsally, outer third with sharp spines especially on dorsal side, tip slightly hooked dorsally.

The genitalia seem to be quite closely related to *usitata* n. sp. although the pygofer hook is narrower in middle and the oedagus is longer and more curved. The external appearance of the two species is not at all alike, *bella* having most of clavi red whilst the other appears spotted.

77. **Erythroneura univittata** Rob.

Erythroneura univittata Robinson, Wm. Can. Ent., Vol. LVI, No. 7, p. 156, 1924.

Genitalia. Pygofer hook single, extending beyond pygofer, S-curved. Style with medium foot; base slightly curved; heel large; anterior point short, slightly less than right angle, projects out; posterior point narrower and slightly longer, projects at right angles to base of foot. Oedagus of medium size, almost straight from any view, roughened with ridges.

This is another species with the tip of anchor-shaped spot broadened so as to give the appearance of a median cross-band.

78. **Erythroneura trivittata** Rob.

Erythroneura trivittata Robinson, Wm. Can. Ent., Vol. LVI, No. 3, p. 59; 1924.

Genitalia. Pygofer hook single, extending almost to tip of pygofer, almost parallel-sided, gently incurved. Style with medium foot; base curved; heel small; anterior and posterior points of about same length, anterior much wider at base and extending slightly out, posterior much narrower and sharper, extending at about right angles to base of foot. Oedagus of medium length, almost straight in any view, sides almost parallel, tip rounded, opening near ventral surface.

79. **Erythroneura texana** Beamer.

Erythroneura texana Beamer, R.H., Annals Ent. Soc. Am., Vol. XXII, p. 116; 1929.

This species has not been taken since the type series.

80. **Erythroneura torella** Rob.

Erythroneura torella Robinson, Wm. Can. Ent., Vol. LVI, No. 7, p. 156, 1924.

Genitalia. Pygofer hook single, ends just short of tip of pygofer, gradually tapering throughout, outer third bent sharply in. Style with medium foot; base curved; heel small; toe narrow; anterior point short, slightly less than a right angle; posterior point as long as foot, sides almost parallel, extends at about right angle to foot. Oedagus of medium length, dorsa-ventrally flattened, very broad at base, tapering gently to rounded tip, lateral margins on outer half with sharp teeth.

81. **Erythroneura kansana** Bk.

Erythroneura kansana Baker, Phil. Jr. Sci.; 1925 (n.n. for *scutelleris* (Gill.)).
Typhlocyba comes var. *scutelleris* Gillette, C.P. Proc. U. S. Nat. Mus., Vol. XX, p. 764; 1898; McAtee, W.L., Trans. Am. Ent. Soc., XLVI, p. 294; 1920; Robinson, Wm. Univ. of Kans. Sci. Bul., Vol. XVI, No. 3; 1926.

This is a red marked species with scutellum and often most of the pronotum dark. The dark marking easily separating it from all others of this group.

Genitalia. Pygofer hook single, reaching almost to end of pygofer, bifid on outer third. Style with short foot; base almost straight; heel prominent; anterior point short, rather sharp, projecting slightly out; posterior point longer than width of toe, more slender than anterior. Oedagus of medium length, quite broad at base, tapering gradually to tip, lateral margins of outer fourth with rather sharp teeth.

82. **Erythroneura kansana** var. **ardens** McAtee

Erythroneura maculata var. *ardens* McAtee, W.L. Trans. American Ent. Soc., XLVI, 299, 1920.

The genitalia of the type of this species are identical with those of *E. (scutellaris) kansana* Bk. Therefore, *ardens* is a variety of this species instead of *maculata* (Gill.).

83. **Erythroneura kansana** var. **insolita** McA.

Erythroneura scutelleris var. *insolita* McAtee, Ill. Nat. Hist. Surv. Bul., Vol. XVI, Art. III, p. 133, 1926.

An examination of the type specimens of this variety showed quite clearly that they are teneral specimens of *E. kansana* Bk.

84. **Erythroneura era** McAtee

Erythroneura maculata var. *era* McAtee, L.L. Trans. Ent. Soc. XLVI, 267-322, August 26-20.

The following is the original description: "Middle of clavus has a distinct red band, which is extended more or less continuously across corium to front of costal plaque; subsidiary tegminal markings red.

Length, 2.64 mm.; vertex: M 6.5, LE 4, "A 10," P 18, OA 5, OP 9, OH 15; pronotum: L 10, "19; tegmen 12-53. (Measurements from a paratype).

Type—male; (2.9 mm.), Maywood, Alexandria County, Virginia, Feb. 20, 1916, (W. L. McAtee), ("L. M.). Paratypes (2.64 to 2.9 mm.). from same locality, January 2, 1916, (W. L. M.).

General ground color yellowish white to semihyaline with a brownish tinge on vertex and pronotum. Color markings red, quite indistinct on vertex pronotum and scutellum. Semblance of usual maculata group markings on these parts. Clavi with a large rectangular red spot in middle of basal half and a smaller spot just before tip. Coria with small dash midway between costal plaque and humeral angle, a larger red blotch at anterior end of costal plaque joining with red spot of clavi at claval suture forming a red-cross band; another angulate vitta arises at posterior end of costal plaque, circles most of it but does not unite with median blotch, ends just before base of cell M_4. Cross-veins more or less reddish. Small black spot in posterior end of costal plaque and larger one in base of cell M_4. Tips of tegmen more or less dusky. Venter mostly stramineous with face brownish.

Genitalia. Pygofer hook single, rather long with medium S-curve. Style with long foot; base curved; heel large; anterior point less than a right angle projecting outward; practically no posterior point much larger

than a right angle. Oedagus of medium length, straight, tapered to a rather sharp tip in lateral view.

Holotype male in collection of W. L. McAtee, Washington, D. C.

85. **Erythroneura rubraza** Rob.

Erythroneura rubraza Robinson, Wm. Can. Ent., Vol. LVI, No. 12, p. 291; 1924.

Characterized externally usually by a more or less rectangular orange spot on pronotum and outer end of basal claval spot enlarged to give the appearance of a pink cross-band.

Genitalia. Pygofer hook single, extending almost to tip of pygofer, widest on basal half, tapering on outer half, inner margin almost straight outer slightly S-curved. Style with medium foot; base slightly curved; heel medium; anterior point short, about a right angle; posterior point longer than width of toe, about twice as long as width at base. Oedagus of medium length, slightly curved dorsally in lateral view, more or less covered with low ridges.

The pygofer hook of this species may be confused with that of *E. contracta* Beamer but may be separated from that species by the pygofer hook tapering for about half its length while *contracta* tapers for about the outer third, *E. contracta* does not have the median cross-banded appearance either.

86. **Erythroneura morgani** (DeL.).

Typhlocyba morgani Delong, D.M., Tenn. State Board of Ent., Bull. 17, Vol. V, No. 2, p. 104; 1916.

Erythroneura morgani (DeL.) McAtee, W.L. Trans. Am. Ent. Soc., XLVI, p. 292; 1920; Robinson, Wm., Univ. of Kans. Sci. Bull., Vol. XVI, No. 3, p. 119; 1926.

This is a beautiful species of wide distribution, easily recognized by the two dark crossbands.

Genitalia. Pygofer hook single, extending almost to tip of pygofer, slightly incurved, an enlarged place on inner margin two-thirds distance to tip. Style with large foot; toe very slender; heel large; base curved; anterior point very short about a right angle; posterior point almost as long as foot, about as wide as toe and extending at right angles to it. Oedagus of medium length, very broad at base, tapering to tip, toothed on lateral margins, dorsoventrally flattened and ending in dorsally bent lip.

87. **Erythroneura lawsoni** Rob.

Erythroneura lawsoni Robinson, Wm., Can. Ent., Vol. LVI, No. 3, p. 59; 1924. Univ. of Kans. Sci. Bull., p. 125, 1926.

Erythroneura mediana Robinson, Wm. Can. Ent., Vol. LVI, No. 7, p. 156; 1924. University of Kansas Science Bull. Vol. XVI, No. 3, March 1926.

This is one of the commoner as well as one of the larger species of grape leaf hoppers. It has been collected in the following states: Kansas, Arkansas, Texas, Iowa, Oklahoma, Illinois, Maryland, and Washington, D.C.

Genitalia. Pygofer hook single, extends slightly beyond tip of pygofer, straight to just before tip where it bends very gently out, broadest at base, tapering evenly to tip. Style with large foot; base curved; heel large; toe narrow; anterior point short, slightly less than right angle; posterior point longer than length of foot, almost parallel-sided, tip slightly outcurved, forming less than right angle with foot. Oedagus of medium length, dorsoventrally flattened, about half as wide as long near middle, lateral edges with sharp teeth, tip of shaft ending in a short dorsally bent lip.

A dissection of the type of *E. lawsoni* revealed genitalia identical with those of *E. mediana* Rob. Since *E. lawsoni* Rob. has priority by a few months *E. mediana* Rob. falls into synonomy.

88. **Erythroneura ligata** McA.

Erythroneura ligata McAtee, W.L., Trans. Am. Ent. Soc., Vol. XLVI, p. 301; 1920; Robinson, Wm., Univ. of Kans. Sci. Bull., Vol. XVI, No. 3, p. 128; 1926.

Genitalia. Pygofer hook single, extending to end of pygofer, sides almost parallel, evenly curved in from base to tip. Style with heavy foot; base posteriorly swollen; heel not prominent; anterior point very short, less than a right angle, projecting out; posterior point two-thirds as long as foot, very narrow, projects at about right angles to base of foot, meets it in a rounded curve. Oedagus short, in lateral view outer half curves ventrally, tip rounded, marked with ridges.

89. **Erythroneura ligata** var. **allecta** McA.

Erythroneura ligata var. *allecta* McAtee, W.L., Trans. Am. Ent. Soc., LXVI, p. 302; 1920.

The dissection of a male compared with the type in the U. S. Nat. Mus. proved to be identical with *E. ligata* McA. differing only in the color markings as set out in the original description.

90. **Erythroneura ligata** var. **pupillata** McA.

Erythroneura ligata var. *pupillata* McAtee, W.L., Ill. Nat. Sur. Bull. Vol. XV, Art. II, p. 42; 1925.

The dissection of a male paratype proves this species to be just as named a variety of *E. ligata* McA.

91. **Erythroneura illinoiensis** (Gill.)

Typhlocyba illinoiensis Gillette, C.P. Proc. U. S. Nat. Mus., Vol. XX, p. 758; 1898.

This is a beautiful red and black spotted species widely distributed throughout the United States.

Genitalia. Pygofer hook single, almost straight, quite short, sharply narrowed on outer half. At base about one-fourth as wide as length. Style with almost no foot, points practically on end of style; heel absent; toe widened; anterior point narrow and sharp, projecting out; posterior point twice as wide, about same length, projecting in. Oedagus of medium length, almost straight, gradually widening to outer fourth where it narrows to rounded tip; shaft with two slightly diverging processes arising near base on ventral side, extending almost to tip, each becoming slightly wider to outer third then narrowing to knife-like points.

92. **Erythroneura illinoiensis** var. **regalis** Beamer.

Erythroneura illinoiensis var. *regalis* Beamer, R.H. Annals Ent. Soc. Am., Vol. XXII, p. 125; 1929.

Like *E. illinoiensis* (Gill.) but much larger and the black spots on coria are elongated.

93. **Erythroneura illinoiensis** var. **spectra** McA.

Erythroneura illinoiensis var. *spectra* McAtee, W.L. Trans. Am. Ent. Soc., XLVI, p. 292; 1920.

A dissection of the type of this variety shows it to be identical with *E. illinoiensis* (Gill.) differing only as to color markings.

94. **Erythroneura hartii** (Gill.).

Typhlocyba hartii Gillette, C.P. Proc. U. S. Nat. Mus., Vol. XX, p. 754; 1898.

Erythroneura hartii (Gill.) W.L. McAtee, Trans. Am. Ent. Soc., XLVI, p. 293, August 26, 1920; Robinson, Wm. Univ. of Kans. Sci. Bull. Vol. XVI, No. 3, Mar. 1926.

A beautiful species marked with brilliant red back to cross-veins except a large discal spot of ivory white.

Genitalia. Pygofer hook single, shorter than pygofer, evenly curved in and tapered on outer third. Style with long slender foot; base almost straight; heel small; anterior point short about a right angle; posterior point as long as width of toe, projecting from it at a right angle, narrow, sharp pointed. Oedagus long, heavy base, straight shaft to just before tip where it is flattened and bent dorsally almost at right angles to shaft.

95. **Erythroneura hymac** Rob.

Erythroneura hymac Robinson, Wm. Can. Ent., Vol. LVI, No. 3, p. 60; 1924. University of Kans. Sci. Bull., Vol. XVI, No. 3, Mar. 1926.

This species is distinctly a red spotted one with the spots appearing as though they were just fading out.

Genitalia. Pygofer hook single, sickle shaped, projecting out from pygofer, tip narrowed sharply. Style with small foot; base curved; heel small but pronounced; anterior point short, slightly less than right angle; posterior point sharper and narrower than anterior but about same length. Oedagus short, almost straight, cylindrical.

The peculiar pygofer hook of this species is quite characteristic and easily separates it from all others.

96. **Erythroneura carmini** Beamer.

Erythroneura carmini Beamer, R.H. Annals Ent., Soc. Am., Vol. XXII, p. 121, 1929.

Since this species was described with a distribution from Kansas to Arizona it has been taken in the following localities: Southern Ill.; Natchitoche Parish, La.; Zoological Park, Washington, D.C.; Batesburg, South Carolina; Glen Echo, Md.; Ames, Iowa; Tuskahoma, Okla.; Sloss, Colo.; and Cedar City, Utah.

97. **Erythroneura campora** Rob.

Erythroneura campora Robinson, Wm. Can. Ent., Vol. LVI, No. 3, p. 59; 1924. University of Kans. Sci. Bull., Vol. XVI, No. 3, p. 124; 1926.

This is one of the commonest species of Erythroneura. Since the descriptions by Robinson are quite adequate for the general appearance of this species I will omit it.

Genitalia. Pygofer hook single, about as long as pygofer, slightly curved in, sides almost parallel. Style with foot of medium length; base straight; heel medium; anterior point short about a right angle; posterior point about as long as width of toe, sharp. Oedagus of medium length, almost straight and parallel-sided.

98. **Erythroneura basilaris** (Say).

Tettigonia basilaris Say, Thomas Jr. Ac. Nat. Sci. Phila., IV, 1825, p: 345. Comp. Writings, II, 1859, p. 260.

"Pale yellowish, varied with sanguineous; elytra reddish-brown at base. Inhabits Missouri.

Body pale yellowish; head obsoletely varied with sanguineous; eyes dusky or black; thorax dusky behind; anterior margin with four or five obsolete sanguineous spots; scutel dusky reddish-brown at base; a spot on the middle of the thinner margin, then an oblique line, and another oblique line towards the tip, sanguineous; at the inner extremity of the latter is a very minute black point.

Length to the tip of the hemelytra, one-ninth of an inch."

General ground color semihyaline to yellowish white marked with orange to reddish-brown. Vertex with semblance of five white spots more or less surrounded with orange bands. Pronotum usually darkened on posterior half, with median orange Y-shaped mark and usual angular spots back of each eye. Scutellum often entirely brown but sometimes with orange tip, basal angles yellow, margined on outer sides with orange. Clavi with basal two-thirds either reddish-brown or with orange anchor-shaped mark leaving a white area on the mesal line of varying extent, tip with red or orange spot. Coria either reddish-brown back to plaque or marked with the usual spots in that area of varying length and width. Spots on outer half extremely variable. Black spot in base of cell M_4. Cross-veins more or less reddish. Tips of tegmen more or less dusky. Venter stramineous tinged with pink, except abdomen which is usually dusky especially on dorsum.

Genitalia. Pygofer hook single, long, with S-curve, about same width throughout. Style with medium foot; base straight; heel small; anterior point short about a right angle; posterior point longer, quite sharp. Oedagus of medium length, straight, almost parallel-sided.

Neotype; male, Anderson Co., Kansas, November 26, 1927, R. H. Beamer.

Light colored specimens of this species may often be confused with *E. affinis* Fitch but may be separated from that species by the male genitalia.

99. **Erythroneura affinis** Fitch.

Erythroneura affinis Fitch, Asa Cat. State Cabinet, N.Y., p. 63, 1851. Lintner, Reprint, 1893, p. 403.

"Pale yellow; elytra hyaline, spotted with light yellow, with a black dot on the inner margin towards the apex, and a broad yellowish brown band on the base. Allied to *basilaris* Say, but readily distinguished, being destitute of sanguineous markings. Length, 0.12. No. 822, female."

General ground color semihyaline to white marked with orange. Vertex with semblance of five white spots more or less surrounded with orange bands. Pronotum with median Y-shaped mark and usual angular spots back of each eye. Scutellum with tip orange, basal angles yellow surrounded on two sides by orange band. Clavi with basal anchor-shaped spot and small spot before tip. Coria with dash at base and irregular-sided more or less connected zigzag vittae arising at anterior end of costal plaque and ending just before base of cell M_4 Cross-veins partially orange. Black spot in base of cell M_4 but the one usually found in posterior end of plaque absent. Tips of tegmina more or less dusky. Venter stramineous tinged with pink except the abdomen which is dusky on both ventral and dorsal sides.

Genitalia. Pygofer hook single, short, almost straight, heaviest at base. Style with medium foot; base straight; heel small; anterior point short about a right angle; posterior point almost as long as width of toe, narrow and sharp. Oedagus of medium length, almost straight in any view, slightly tapering from base to tip, some ridges on surface.

Allotype; male, Douglas Co., Kans., May 13, 1924, R. H. Beamer.

This species is much like some light colored specimens of *E. basilaris* (Say) but may be separated from them by the much shorter and almost straight pygofer hook.

100. **Erythroneura bigemina** Mc.A.

Erythroneura maculata var. *bigemina* McAtee, W.L. Trans. Amer. Ento. Soc., XLVI, p. 300, 1920.

Typhlocyba comes var. *apicalis* DeLong, Dwight M. Tenn. State Board of Ent., Bull. No. 17, Vol. V, No. 2, p. 108, 1916.

Although *apicalis* (Delong) has priority over *bigemina* McAtee it is preoccupied by *E. apicalis* Nawa of Japan. Konchu Sekai (Insect World), Gifu, Vol. XVII, p. 480-486, pl. xxiv, 1913.

The type female of this species in McAtee's collection was taken in August and was not as highly colored as winter specimens. The following is a description of a specimen from Nashville, Tenn., taken in winter with genitalia identical with the type:

General ground color semihyaline to yellowish white marked with red. Vertex with semblance of three circular and two semi-circular white spots more or less surrounded with broad red bands. Pronotum with median Y-shaped mark almost or quite touching both margins, usual angular spots back of each eye. Scutellum with spot on tip, basal angles yellow surrounded on two sides with red. Clavi with usual red anchor-shaped spot and large rectangular spot before tip. Coria with rather heavy dash on costa midway between humeral angle and costal plaque, an irregular-sided zigzag vitta arising on costa at anterior end of plaque, surrounding it and ending just before base of cell M_4. The widened posterior portion of the vitta with the coloring often present on the apical portion of M_1 and Cu tend to give the tegmina a red banded appearance. Cross-veins red. Black spot in base of cell M_4 and much smaller one in posterior end of plaque. Tips of tegmina more or less dusky. Face with narrow red V-shaped cross band. Venter stramineous tinged with pink.

Genitalia. Pygofer hook single, slightly longer than pygofer, slightly S-curved, almost parallel-sided. Style with medium foot; base straight; heel medium; anterior point short, about as broad as long, projects out; posterior point narrow, not over half as wide at base as length, forming about a right angle with base. Oedagus with shaft of moderate length, slightly tapering from base to tip, practically straight in any view, some rough marks or ridges at least on outer half.

This is a very common species and is close to *E. campora* Rob. from which it can be distinguished by the S-curve in the pygofer hook.

101. **Erythroneura californica** n. n.

Erythroneura coryli Van Duzee, E.P. Proc. Calif. Acad. Sci., 4th series, vol. xiii, no. 13, p. 234, 1924.

The name *coryli* was, no doubt, inadvertently used by Van Duzee as it had already been used for a European species by Oshanin 1912.

Summer specimens of this species show a great range in tegminal coloring with females usually having the widest markings.

Genitalia. Pygofer hook single, almost parallel-sided widening slightly into bifid tip, inner spine extending in at right angles to shaft, much longer than outer. Style with medium foot; base curved; heel large; toe quite slender; anterior point very short, about a right angle; posterior point at least two-thirds as long as foot, barely narrower than toe. Oedagus of medium length, about two-thirds as wide as long in ventral view, tip rounded with some spines.

Mr. Van Duzee took the author to a lovely collecting spot in Marin Co., Calif., Aug. 3, 1929, where a series of 94 females and 33 males of this beautiful species were taken.

(to be continued)

THE OCCURRENCE OF ATLIDES HALESUS (LEPID: LYCAENIDAE) IN NORTHWESTERN OREGON

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To my knowledge *Atlides halesus* has not been reported previously as occuring farther north than about thirty-eight degrees N. latitude (southern Illinois), so I believe its presence in north-western Oregon is worth recording. McMinnville, the location at which I took the examples, is more than seven degrees farther north than points of previous capture. Comstock (Butterflies of Cal., 1927) mentions that this insect is not common in California but that it is recorded from many parts of that state.

My first two Oregon specimens of *halesus* were taken July 18, 1919, at the edge of a barnyard mud-puddle, and the second two were taken in the same barnyard during the following year: one July 21 and the other July 22. All of these butterflies had more or less frayed wings although one was in quite fair condition. They are now in my collection at McMinnville, Oregon.

It is a question as to whether this hair-streak would breed so far north or whether these captures were merely stragglers from the South. I am inclined to favor the latter view for in all my specimens the wings were somewhat broken, and no other examples are known to have been taken before or since in the state. However, the former view would also have some support in that specimens were taken in the same place two years in succession (and not elsewhere in the region), and in that mistletoe, the food plant of the species, grows in great abundance in the oaks (Quercus garryana) of the vicinity. The climate of northwestern Oregon is very mild with little freezing weather, a condition which might favor the breeding of these insects.

I feel that these northern records of *Atlides halesus* are interesting in that they considerably extend the range of this brilliantly-marked southern hair-streak.

Mailed Saturday, July 2nd, 1932.